TOPIC 05 – ENERGETICS
5.4: BOND ENTHALPIES

IB Chemistry

T05D06

5.4 Bond enthalpies - 2 hours

- 5.4.1 Define the term average bond enthalpy. (1)
- 5.4.2 Explain, in terms of average bond enthalpies, why some reactions are exothermic and others are endothermic. (3)

5.4 – Bond Enthalpies

- The **bond enthalpy** (bond energy) is the amount of energy required to break one mole of a specific covalent bond between two atoms in one mole of gaseous molecules.
- Measured using a **mass spectrometer**
- Energy is required to overcome (or break) the attractive forces between the shared pair of electrons and the nuclei.
- The bond breaking process is therefore **endothermic**
  - Bond formation then is always **exothermic**

5.4 – Covalent Bond Strength

- The **strength** of a covalent bond is indicated by the **size** of the bond dissociation enthalpy.
- The larger the bond enthalpy, the stronger the covalent bond
- Bond enthalpy is **inversely proportional** to the bond length
- Bond enthalpies are represented in **average** values taken from various compounds (hydrocarbons, etc)
- Since average values are used, bond enthalpies are simply approximations and will not be as exact as experimental values

5.4 – Bond Dissociation Energies

- Bond enthalpies can be used to determine the enthalpy change for a particular reaction involving molecules in the gaseous state, for example the combustion of methane

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

- The reaction is regarded in **two steps**
  - First, all the bonds in reactants must be **broken**
    - This process is **endothermic** and heat energy is lost
  - Second, the **bond formation** occurs
    - This process is **exothermic** since the energy released during bond formation is greater than the energy absorbed during bond breaking

5.4 – CH_4 Combustion Bond Energy

- Example will be added when image is captured

5.4 – Combustion of CH_4 Example

- $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
- Bond Breaking
  - Breaking 4 x C-H bonds = 4 x 412kJ = 1648 kJ
  - Breaking 2 x O=O bonds = 2 x 496kJ = 992 kJ
  - Total Bond breaking = 2640 kJ
- Bond Making
  - Making 2 x C=O bonds = 2 x 743 kJ = 1486 kJ
  - Making 4 x 0-H bonds = 4 x 463 kJ = 1852 kJ
  - Total Bond making = 3338 kJ

5.4 – Enthalpy Chang of Reaction

- The enthalpy change of reaction when using bond energies can be obtained by the following equation

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- From last slide
  - Bond Breaking = 2640 kJ
  - Bond Making = 3338 kJ
  - $\Delta H = (2640 - 3338) = -698$ kJ
  - Combustion, therefore value is exothermic and negative, check √

5.4 – Endo vs Exo

- In the previous example, the amount of energy released when new bonds were formed was greater than the amount necessary to break the bonds, therefore the reaction was **exothermic**
- If the energy released upon bond formation is not equal to or greater than what was required to break the bonds, the reaction is then **endothermic**

5.4 – Graphs of Endo & Exo

- The following images will be added when captured


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